

CLAIMS

I/We claim:

- [c1] 1. A system for depositing material onto a workpiece in a reaction chamber, the system comprising:
- a gas phase reaction chamber;
 - a first exhaust line coupled to the reaction chamber;
 - a first trap and a second trap each in fluid communication with the first exhaust line, the first and second traps being operable independently to individually and/or jointly collect byproducts from the reaction chamber; and
 - a vacuum pump coupled to the first exhaust line to remove gases from the reaction chamber.
- [c2] 2. The system of claim 1 wherein the first exhaust line comprises a first branchline and a second branchline each downstream from the reaction chamber, the first trap being disposed in the first branchline and the second trap being disposed in the second branchline, the first and second branchlines being configured in a parallel arrangement.
- [c3] 3. The system of claim 1 wherein:
- the first exhaust line comprises a first branchline and a second branchline each downstream from the reaction chamber, the first trap being disposed in the first branchline and the second trap being disposed in the second branchline; and
 - the system further comprises a throttling valve in the second branchline to control the flow of byproducts into the second branchline.

[c4]

4. The system of claim 1 wherein:

the first exhaust line comprises a first branchline and a second branchline each downstream from the reaction chamber, the first trap being disposed in the first branchline and the second trap being disposed in the second branchline; and

the system further comprises –

a throttling valve in the second branchline to control the flow of byproducts into the second branchline;

a pressure monitor to determine the difference between the pressure in the first exhaust line upstream from the first trap and the pressure in the first exhaust line downstream from the first trap; and

a controller operably coupled to the throttling valve and the pressure monitor to control the flow of byproducts into the second branchline to maintain the pressure differential in the first exhaust line within a desired range.

[c5]

5. The system of claim 1 wherein:

the first exhaust line comprises a first branchline and a second branchline each downstream from the reaction chamber;

the vacuum pump comprises a first vacuum pump coupled to the first branchline; and

the system further comprises a second vacuum pump coupled to the second branchline.

[c6]

6. The system of claim 1 wherein:

the first exhaust line comprises a first branchline and a second branchline each downstream from the reaction chamber, the first trap being disposed in the first branchline and the second trap being disposed in the second branchline; and

the system further comprises a first valve in the first branchline upstream of the first trap and a second valve in the first branchline downstream of the first trap.

[c7] 7. A system for depositing material onto a workpiece in a reaction chamber, the system comprising:

- a low-pressure gas phase reaction chamber;
- a first line coupled to the reaction chamber, the first line having a first branchline and a second branchline;
- a first collector disposed in the first branchline and a second collector disposed in the second branchline; and
- a vacuum pump coupled to the first line to remove gas from the reaction chamber via the first branchline and/or the second branchline.

[c8] 8. The system of claim 7, further comprising a throttling valve in the second branchline to control the flow of byproducts into the second branchline.

[c9] 9. The system of claim 7, further comprising:

- a throttling valve in the second branchline to control the flow of byproducts into the second branchline;
- a pressure monitor to determine the difference between the pressure in the first line upstream from the first collector and the pressure in the first line downstream from the first collector; and
- a controller operably coupled to the throttling valve and the pressure monitor to control the flow of byproducts into the second branchline to maintain the pressure differential in the first line within a desired range.

[c10] 10. The system of claim 7 wherein:
the vacuum pump comprises a first vacuum pump coupled to the first branchline; and
the system further comprises a second vacuum pump coupled to the second branchline.

[c11] 11. A system for depositing material onto a workpiece in a reaction chamber, the system comprising:
a gas phase reaction chamber;
a first exhaust line coupled to the reaction chamber;
a trap in the first exhaust line to collect byproducts from the reaction chamber; and
a first vacuum pump and a second vacuum pump each in fluid communication with the first exhaust line and downstream from the trap, the first and second vacuum pumps being operable independently to individually and/or jointly exhaust byproducts from the reaction chamber.

[c12] 12. The system of claim 11 wherein the first exhaust line comprises a first branchline and a second branchline each downstream from the reaction chamber, the first vacuum pump being coupled to the first branchline and the second vacuum pump being coupled to the second branchline.

[c13] 13. The system of claim 11 wherein:
the first exhaust line comprises a first branchline and a second branchline each downstream from the reaction chamber, the first vacuum pump being coupled to the first branchline and the second vacuum pump being coupled to the second branchline; and
the system further comprises a throttling valve in the second branchline to control the pressure in the first exhaust line.

[c14]

14. The system of claim 11 wherein:

the first exhaust line comprises a first branchline and a second branchline each downstream from the reaction chamber, the first vacuum pump being coupled to the first branchline and the second vacuum pump being coupled to the second branchline; and
the system further comprises –

a throttling valve in the second branchline;

a pressure monitor to determine the pressure in the first exhaust line; and

a controller operably coupled to the throttling valve and the pressure monitor to maintain a generally consistent pressure in the first exhaust line.

[c15]

15. The system of claim 11 wherein:

the first exhaust line comprises a first branchline and a second branchline each downstream from the reaction chamber;

the trap comprises a first trap disposed in the first branchline; and

the system further comprises a second trap disposed in the second branchline.

[c16]

16. A system for depositing material onto a workpiece in a reaction chamber, the system comprising:

a reaction chamber;

a first mainline coupled to the reaction chamber, the first mainline having a first branchline and a second branchline each downstream from the reaction chamber;

a first trap in the first branchline to collect byproducts from the reaction chamber;

a second trap in the second branchline to collect byproducts from the reaction chamber;

a throttling valve in the second branchline;
a pressure monitor to determine the difference between the pressure in the first mainline upstream from the first trap and the pressure in the first mainline downstream from the first trap;
a vacuum pump coupled to the first mainline; and
a controller operably coupled to the pressure monitor and the throttling valve, the controller having a computer-readable medium containing instructions to perform a method comprising –
exhausting byproducts from the reaction chamber through the first mainline; and
dynamically controlling the flow of byproducts into the second branchline to maintain the pressure differential in the first mainline within a desired range.

[c17] 17. The system of claim 16 wherein the first branchline and the second branchline are configured in a parallel arrangement.

[c18] 18. The system of claim 16 wherein:
the first mainline further includes a third branchline and a fourth branchline each downstream from the first and second branchlines;
the vacuum pump comprises a first vacuum pump coupled to the third branchline; and
the system further comprises a second vacuum pump coupled to the fourth branchline.

[c19] 19. The system of claim 16 wherein the throttling valve comprises a first valve, and wherein the system further comprises a second valve in the first branchline upstream of the first trap and a third valve in the first branchline downstream of the first trap.

[c20]

20. A system for depositing material onto a workpiece in a reaction chamber, the system comprising:

- a reaction chamber;
- a first mainline coupled to the reaction chamber, the first mainline having a first branchline and a second branchline each downstream from the reaction chamber;
- a first trap in the first branchline to collect byproducts from the reaction chamber;
- a second trap in the second branchline to collect byproducts from the reaction chamber;
- a throttling valve in the second branchline;
- a pressure monitor to determine the difference between the pressure in the first mainline upstream from the first trap and the pressure in the first mainline downstream from the first trap;
- a vacuum pump coupled to the first mainline; and
- a controller operably coupled to the pressure monitor and the throttling valve, the controller having a computer-readable medium containing instructions to perform a method comprising –
 - exhausting byproducts from the reaction chamber through the first mainline;
 - collecting byproducts in the first trap in the first branchline;
 - monitoring the difference between the pressure in the first mainline upstream of the first trap and the pressure in the first mainline downstream of the first trap; and
 - regulating the throttling valve in the second branchline in response to the monitored pressure differential in the first mainline to flow byproducts into the second branchline to maintain the pressure differential in the first mainline within a desired range.

[c21] 21. The system of claim 20 wherein the first branchline and the second branchline are configured in a parallel arrangement.

[c22] 22. The system of claim 20 wherein:
the first mainline further includes a third branchline and a fourth branchline each downstream from the first and second branchlines;
the vacuum pump comprises a first vacuum pump coupled to the third branchline; and
the system further comprises a second vacuum pump coupled to the fourth branchline.

[c23] 23. The system of claim 20 wherein the throttling valve comprises a first valve, and wherein the system further comprises a second valve in the first branchline upstream of the first trap and a third valve in the first branchline downstream of the first trap.

[c24] 24. A method for removing byproducts from a reaction chamber through a first mainline, the first mainline being coupled to the reaction chamber and having first and second branchlines downstream from the reaction chamber, the method comprising:
exhausting byproducts from the reaction chamber through the first mainline;
collecting byproducts in a first trap in the first branchline of the first mainline; and
collecting byproducts in a second trap in the second branchline of the first mainline.

[c25] 25. The method of claim 24, further comprising dynamically controlling the flow of byproducts into the second branchline to maintain a pressure differential in the first mainline within a desired range.

[c26] 26. The method of claim 24, further comprising dynamically controlling the flow of byproducts into the second branchline to maintain a generally consistent throughput in the first mainline.

[c27] 27. The method of claim 24, further comprising:
monitoring the difference between the pressure in the first mainline upstream from the first trap and the pressure in the first mainline downstream from the first trap; and
regulating a throttling valve in the second branchline in response to the monitored pressure differential in the first mainline to flow byproducts into the second branchline to maintain the pressure differential in the first mainline within a desired range.

[c28] 28. The method of claim 24, further comprising:
closing a first valve in the first branchline upstream from the first trap and a second valve in the first branchline downstream from the first trap;
and
servicing and/or replacing the first trap while collecting byproducts in the second trap.

[c29] 29. The method of claim 24 wherein the first mainline further comprises a third branchline and a fourth branchline each downstream from the first and second branchlines, and wherein the method further comprises:
drawing byproducts from the reaction chamber through the first mainline with a first vacuum pump coupled to the third branchline of the first mainline; and
drawing byproducts from the reaction chamber through the first mainline with a second vacuum pump coupled to the fourth branchline of the first mainline.

[c30] 30. A method for removing byproducts from a reaction chamber through a first mainline, the first mainline having first and second branchlines downstream from the reaction chamber, the method comprising:

exhausting byproducts from the reaction chamber through the first mainline; and

dynamically controlling the flow of byproducts into the second branchline of the first mainline to maintain a pressure differential in the first mainline within a desired range.

[c31] 31. The method of claim 30, further comprising:
collecting byproducts in a first trap in the first branchline of the first mainline; and
collecting byproducts in a second trap in the second branchline of the first mainline.

[c32] 32. The method of claim 30, further comprising:
monitoring the difference between the pressure in the first mainline upstream from a first trap and the pressure in the first mainline downstream from the first trap, the first trap being disposed in the first branchline;
wherein dynamically controlling the flow of byproducts comprises regulating a throttling valve in the second branchline in response to the monitored pressure differential in the first mainline to maintain the pressure differential in the first mainline within the desired range.

[c33] 33. The method of claim 30 wherein the first mainline further comprises a third branchline and a fourth branchline each downstream from the first and second branchlines, and wherein the method further comprises:

drawing byproducts from the reaction chamber through the first mainline with a first vacuum pump coupled to the third branchline of the first mainline; and

drawing byproducts from the reaction chamber through the first mainline with a second vacuum pump coupled to the fourth branchline of the first mainline.

[c34] 34. A method for removing byproducts from a reaction chamber, the method comprising:

exhausting byproducts from the reaction chamber through a first mainline; collecting byproducts in a first trap in a first branchline of the first mainline; monitoring the difference between the pressure in the first mainline upstream from the first trap and the pressure in the first mainline downstream from the first trap; and

regulating a throttling valve in a second branchline of the first mainline in response to the monitored pressure differential in the first mainline to flow byproducts into the second branchline to maintain the pressure differential in the first mainline within a desired range.

[c35] 35. The method of claim 34, further comprising collecting byproducts in a second trap in the second branchline.

[c36] 36. The method of claim 34 wherein the throttling valve comprises a first valve, and wherein the method further comprises:

closing a second valve in the first branchline upstream from the first trap and a third valve in the first branchline downstream from the first trap after regulating the first valve;

collecting byproducts in a second trap in the second branchline; and
servicing and/or replacing the first trap while collecting byproducts in the
second trap.

[c37] 37. The method of claim 34 wherein the first mainline further comprises
a third branchline and a fourth branchline each downstream from the first and
second branchlines, and wherein the method further comprises:

drawing byproducts from the reaction chamber through the first mainline
with a first vacuum pump coupled to the third branchline of the first
mainline; and

drawing byproducts from the reaction chamber through the first mainline
with a second vacuum pump coupled to the fourth branchline of the
first mainline.

[c38] 38. A method for removing byproducts from a reaction chamber, the
method comprising:

removing byproducts from the reaction chamber through a first mainline;
collecting byproducts in a first trap in a first branchline of the first mainline;
closing a first valve in the first branchline upstream from the first trap and a
second valve in the first branchline downstream from the first trap;
servicing and/or replacing the first trap; and
collecting byproducts in a second trap in a second branchline of the first
mainline while the first and second valves are closed.

[c39] 39. The method of claim 38 wherein the first mainline further comprises
a third branchline and a fourth branchline each downstream from the first and
second branchlines, and wherein the method further comprises:

drawing byproducts from the reaction chamber through the first mainline
with a first vacuum pump coupled to the third branchline of the first
mainline; and

drawing byproducts from the reaction chamber through the first mainline with a second vacuum pump coupled to the fourth branchline of the first mainline.

[c40] 40. A method for removing byproducts from a reaction chamber, the method comprising:

drawing byproducts from the reaction chamber through a first mainline with a first vacuum pump coupled to a first branchline of the first mainline; and

drawing byproducts from the reaction chamber through the first mainline with a second vacuum pump coupled to a second branchline of the first mainline.

[c41] 41. The method of claim 40, further comprising collecting byproducts in a trap in the first mainline.

[c42] 42. The method of claim 40 wherein the first mainline further comprises a third branchline and a fourth branchline each upstream from the first and second branchlines, and wherein the method further comprises:

collecting byproducts in a first trap in the third branchline of the first mainline; and

collecting byproducts in a second trap in the fourth branchline of the first mainline.

[c43] 43. The method of claim 40, further comprising dynamically controlling a throttling valve in the second branchline to maintain a generally consistent throughput in the first mainline.

[c44] 44. The method of claim 40, further comprising dynamically controlling a throttling valve in the second branchline to maintain a generally consistent vacuum conductance in the first mainline.

[c45] 45. The method of claim 40, further comprising:
 monitoring a pressure in the first mainline; and
 regulating a throttling valve in the second branchline in response to the
 monitored pressure to maintain a generally consistent pressure in
 the first mainline.